

1 Claim 1. An improved disk centrifuge capable of measuring scattered light at a plurality
2 of angles from a sample undergoing separation therein comprising

3 a) a cylindrically symmetric chamber impressed to rotate about an axis of rotation
4 through its generator, said chamber incorporating a cylindrical fluid-bearing
5 cavity means within circular wall means of said chamber, said cavity extending
6 over a range of radial distances from said axis of rotation, and said walls
7 incorporating region transparent to light over a range of radial distances;

8 b) sample introduction means whereby said sample may be introduced into said
9 cylindrical fluid-bearing cavity between said circular wall means, so that said
10 sample undergoes separation by resultant centrifugal forces as said cylindrical
11 chamber undergoes impressed rotation about said axis of rotation;

12 c) a flat transparent cylindrically symmetric optical region of one of said wall
13 means;

14 d) a stationary external light source means providing a fine beam of light passing
15 successively through said transparent region and said sample undergoing
16 separation;

17 e) a stationary forward transmitted light beam trapping means into which said fine
18 beam of light enters after leaving said transparent region;

19 f) a plurality of stationary detector means arranged about said light beam at varying
20 angles therefrom, each said detector means masked by collimating means to
21 accept only light scattered by said sample means from region of said sample
22 illuminated by said incident light beam and passing through said transparent
23 region; and

1 g) electronic means to convert signals from said scattered light detectors
2 successively in time, converting said signals into digital representations, and
3 transmitting said resultant digital signals to computer means for subsequent
4 processing and analysis.

5

6 **Claim 2.** An improved disk centrifuge capable of measuring scattered light at a plurality
7 of angles from a sample undergoing separation therein comprising

8 a) a cylindrical structure impressed to rotate about an axis of rotation through its
9 generator, said cylindrical structure containing cavity means to incorporate
10 transparent cuvettes, said cuvettes

11 i. containing samples, each said sample undergoing separation by
12 resultant centrifugal forces as said cylindrical structure undergoes
13 impressed rotation about said axis of rotation;

14 ii. having a plane transparent optical surface through which an
15 incident light beam may pass and an opposite plane transparent
16 optical surface to provide a structure with said sample between
17 said two surfaces; and

18 iii. oriented radially so that said resultant centrifugal force separates
19 particles in a radial direction.

20 b) a stationary external light source means providing said fine beam of light passing
21 successively through transparent regions of said optical surfaces of said sample
22 containing cuvette;

- 1 c) a stationary forward transmitted light beam trapping means into which said fine
2 beam of light enters after leaving normally from said transparent cuvette;
- 3 d) a plurality of stationary detector means arranged about said light beam at varying
4 angles therefrom, each said detector means masked by collimating means to
5 accept only light scattered by said sample means from region of said sample-
6 containing cuvette illuminated by said incident light beam and passing through
7 said optical surface means; and
- 8 e) electronic means to convert signals from said scattered light detectors
9 successively in time, converting said signals into digital representations, and
10 transmitting said resultant digital signals to computer means for subsequent
11 processing and analysis.

12

13 Claim 3. An improved analytical ultracentrifuge capable of measuring scattered light at a
14 plurality of angles from a sample undergoing separation therein comprising

- 15 a) a cylindrical structure impressed to rotate about an axis of rotation through its
16 generator, said cylindrical structure containing cavity means to incorporate
17 transparent cuvettes, said cuvettes
- 18 i. containing samples, each said sample undergoing
19 separation by resultant centrifugal forces as said cylindrical structure
20 undergoes impressed rotation about said axis of rotation;
- 21 ii. having a plane transparent optical surface through which an
22 incident light beam may pass and an opposite plane transparent

1 optical surface to provide a structure with said sample contained
2 between said two surfaces; and
3 iii. oriented radially so that said resultant centrifugal force
4 separates particles in a radial direction.

5 b) a first light source means directed normal to said rotating cylindrical structure
6 providing said fine beam of light passing successively through transparent regions
7 of said optical surfaces of said sample containing cuvette;

8 c) a forward transmitted light beam trapping means into which said fine beam of
9 light enters after leaving normally from said transparent cuvette;

10 d) a plurality of light scattering detector means arranged about said light beam at
11 varying angles therefrom, each said light scattering detector means masked by
12 collimating means to accept only light scattered by said sample means from
13 region of said sample-containing cuvette illuminated by said incident light beam
14 and passing through said plane optical surface means;

15 e) a second light source at the same radial distance from said axis of rotation as said
16 first light source providing a second beam of light directed normal to said rotating
17 cylindrical structure and passing through said cuvette when said cuvette has
18 moved to a second angular position;

19 f) a second forward transmitted light beam trapping means into which said second
20 fine beam of light enters after leaving normally from said transparent cuvette

21 g) a second plurality of light scattering detector means arranged about said second
22 light beam at varying angles therefrom, each said light scattering detector means
23 masked by collimating means to accept only light scattered by said sample means

1 from region of said sample-containing cuvette illuminated by said incident light
2 beam and passing through said plane optical surface means;
3 h) a mechanical support means by which said two light beam sources, said two
4 pluralities of light scattering detector means are fixed in space relative to said
5 rotating cylindrical structure rotating therebetween, said mechanical structure
6 permitting its movement in radial position only;
7 i) electronic means to convert signals from said two pluralities of scattered light
8 detectors successively in time, converting said signals into digital representations,
9 and transmitting said resultant digital signals to computer means for subsequent
10 processing and analysis.

11

12 Claim 4. The improved analytical ultracentrifuge of Claim 3 where each said forward
13 transmitted light beam trapping means includes detection means to monitor intensity of
14 said incident transmitted beam

15

16 Claim 5. The improved analytical ultracentrifuge of Claim 3 where said first light source
17 produces a light beam at a wavelength permitting measurement of said sample absorption
18 by said detector monitoring means of said light beam transmitted through said sample
19 means of Claim 4.

20

21 Claim 6. The improved analytical ultracentrifuge of Claim 3 where said second light
22 source is a laser.

23

1 Claim 7. The improved analytical ultracentrifuge of Claim 6 where said laser source is
2 plane polarized in a plane parallel to the radius of said rotating structure holding said
3 sample cuvettes.

4
5 Claim 8. The improved analytical ultracentrifuge of Claim 3 wherein said cuvette optical
6 surface through which said fine light beam passes after its passage through said sample is
7 plane along that region of said cuvette to include a selected range of radial positions
8 along said rotating structure that said fine light beam may travel.

9
10
11 Claim 9. The cuvette of Claim 8 wherein all optical surfaces through which the incident
12 beam and scattered light pass are coated with transparent optical materials to reduce
13 scattering and reflections at all air interfaces.

14
15 Claim 10. The improved analytical ultracentrifuge of Claim 3 where said plurality of light
16 scattering detector means arranged about said light beam at varying angles therefrom lie
17 in a plane perpendicular to said beam.

18
19 Claim 11. The improved disk centrifuge of Claim 2 where said forward transmitted light
20 beam trapping means includes detection means to monitor intensity of said incident
21 transmitted beam.

22

1 **Claim 12.** The improved disk centrifuge of Claim 3 wherein said cuvette optical surface
2 through which said fine light beam passes after its passage through said sample is plane
3 along the length of said cuvette to include a selected range of radial positions.

4
5
6 **Claim 13.** The cuvette of Claim 12 wherein all optical surfaces through which the
7 incident beam and scattered light pass are coated with transparent optical materials to
8 reduce scattering and reflections at all air interfaces.

9
10 **Claim 14.** The improved disk centrifuge of Claim 2 where said plurality of light
11 scattering detector means arranged about said light beam at varying angles therefrom lie
12 in a plane perpendicular to said beam.

13
14 **Claim 15.** The improved disk centrifuge of Claim 1 where said forward transmitted light
15 beam trapping means includes detection means to monitor intensity of said incident
16 transmitted beam.

17
18
19 **Claim 16.** The improved disk centrifuge of Claim 1 wherein all optical surfaces through
20 which the incident beam and scattered light pass are coated with transparent optical
21 materials to reduce scattering and reflections at all air interfaces.

22

1 Claim 17. The improved disk centrifuge of Claim 1 where said plurality of light
2 scattering detector means arranged about said light beam at varying angles therefrom lie
3 in a plane perpendicular to said beam.

4
5 Claim 18. A method for measuring the molecular mass of molecules being separated in
6 an improved analytical ultracentrifuge means incorporating two light sources comprising
7 the steps of

- 8 a) deriving the concentration of said sample at the instant and radial location at
9 which said sample is illuminated by the conventional light beam of said
10 analytical ultracentrifuge by measuring the attenuation of said beam by said
11 sample;
- 12 b) measuring the light scattered by said same sample at the instant and radial
13 location at which said sample is illuminated by a second light beam, said
14 scattered light detected over a range of scattering angles by means of a set of
15 scattered light detectors placed in fixed proximity to rotating cylindrical
16 structure of said ultracentrifuge;
- 17 c) combining said concentration and scattered light data to derive said molecular
18 mass.

19
20 Claim 19. The method of Claim 18 where said conventional light beam source and said
21 second light beam source produce light beams that are co-linear.

22

1 Claim **20**. The method of Claim **18** where said conventional light beam source and said
2 second light beam source produce light beams that are at identical radial distances from
3 the axis of rotation of said improved analytical ultracentrifuge, but at different angular
4 positions.

5

6 Claim **21**. The method of Claim **18** where said conventional light beam source produces
7 UV light and said second light beam source produces light of a different wavelength.

8

9 Claim **22**. The method of Claim **18** where said second light beam source is a laser.